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URBAN MOSQUITO CONTROL
AND
CIVIC BODIES

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Magnitude of Problem:

Urban centers like towns,cities,and metropolises play an important role in the national economy and various fronts of socioeconomic development.

According to 1981 census,in India 159 million (23.3%) people were living in 3245 urban settlements of different shapes and sizes. It needs no scientific forecasting to visualize that by 2000 A.D. 338 million or 31.3% of the total population will be living in 5583 urban centers. The growth of urban centers is also not uniform. It is the class I cities which has grown much faster than the others. This is evident from the fact that the 216 class I cities contain more than 60% of the total urban population whereas the remaining 40% of the urban population is scattered over 3029 centers of different shape and sizes.

This projection is based on the census definition of urban center (the area is classified into urban area where more than 50% of the population are engaged in nonagricultural activity). However such classification has little or no relevance in the context of vector.

An urban area from the point of view of vector control could be defined as an area where Cx. quinquefasciatus is major man biting mosquito.

If one considers this classification more than 50% of the Indian population will be living in areas identical to urban area from the vector point of view but classified as rural according to census. This is mainly due to the fact that under the influence of urban centre many peripheral villages have themselves undergone a process of semi-urbanization.

Such unplanned urbanization manifests itself in the form of sprawling slums with environmental pollution and unprecedented strain on basic sanitary services leading to prolific breeding of vectors and nonvector mosquitoes.

Thus the enormity of urban vector and vector borne disease control problem in terms of distribution shows that over 50% of the population in India would require some sort of protection from urban vector.

Urban Vector and vector borne disease:

In India, *Cx. quinquefasciatus, Anopheles stephensi* and *Aedes aegypti*, the respective vectors of filariasis, malaria and dengue hemorrhagic fever are abundant in urban centers. *It is estimated that approximately 82 million people (more than 50% of urban population) are exposed to risk of filarial infection in urban areas.* The actual malaria situation in urban areas is not clear, as the urban malaria scheme is in operation only in 125 urban centers which alone contributes to more than 10 % of total malaria cases in the country. The gravity of the problem due to other vector borne disease can not be assessed as they either remain undetected under the garb of PUO (Pyrexia of Unknown Origin).

Amongst the vector mosquito *Cx. quinquefasciatus* is the dominant species in almost all the urban centers, whereas density of *An. stephensi* and *Ae. aegypti* vari es from place to place and season to season. In addition, *Cx. tritaeniorhynchus* (vector of Japanese encephalitis) and *An. culicifacies* (vector of Malaria) are also present in peripheral areas of some of the urban centers.

The high vector density in the urban areas is the direct consequence of unplanned urbanisation and gross mismanagement of the environment over the years. The problem is further aggravated by faulty engineering practices.

Present Vector Control Strategy:

At present vector control in urban area is *linked with disease control programmes like Filaria and Malaria.* Since vector control is a part of disease control programme, efforts are made only when malaria appears in epidemic proportion. However, the most common urban vector *Cx. quinquefasciatus* does not evoke much response from disease control programmes as it transmits filariasis, a disease which causes low morbidity and no mortality and mostly the poorer section of the community suffers. Therefore it will not be an exaggeration if one concludes that the *vector control in urban area is practically non existent.* Whatever

is being done by the disease control programme is palliative in nature and no sustained effort is made to control vectors. These measures at best can be termed as public relations measure rather than public health measures. The national strategy on filariasis control is directed against the immature stages of the vector and relies heavily on insecticides. *Inspite of heavy financial inputs for many years the programme did not make any dent in the vector problem.* This is mainly due to the fact that more and more breeding places are added every year to already existing ones, whereas the resources to control were not increased proportionately. Moreover these methods have to be repeated because of the temporary effect of these methods and destabilisation of host - parasite interaction. Most important of all is the improper utilization of insecticides.

What should be done ?

Choice of method in urban vector control: Integrated Vector Management should be followed with the emphasis on source reduction and environmental methods.

Integrated vector management emphasizes the utilization of all appropriate technological and management techniques to bring about an effective degree of suppression in a cost-effective manner (WHO.1983).

Since urban vector problem is due to gross mismanagement of environment, only environmental management can provide long term solution which is known to reduce the carrying capacity of the environment. Breeding of vectors in the habitats present in an urban areas is preventable by various environmental methods and are described elsewhere. The VCRC experience at Pondicherry, Bangalore, Mangalore, Kovur, Hyderabad and other urban centers clearly shows that the vector problem is purely related to the poor sanitary condition of the town. The Government of India is aware of these and had issued the following guidelines in 1969.

i. prevention of filariogenic condition in town expansion and in new townships.

ii. adequate arrangement for disposal of sewage and sullage

iii. recurrent antilarval measures using malaria oil throughout the year along with minor engineering work.

However, while nothing is done about the first two recommendations, only part of the recommendation No.3 is being implemented i.e carrying out recurrent antilarval measures without minor engineering work. Recommendations 1 and 2 can not be implemented by the national programme since these fall under the purview of departments dealing with Housing and urban development, water supply and sanitation.

Who should do vector control

Since urban vector problem is related to sanitation, vector control has to be delinked from the disease control programmes and linked with sanitary services under the direct supervision of a public health engineer. If urban vector control is linked with sanitation,vector control can be achieved by environmental methods in a most cost effective manner by the least trained manpower. This could be done best if local bodies are made responsible for all local problems including health. Local bodies are accountable to the public. Multiplicity of departments only increase the cost of health delivery and reduces the effectiveness of the programme. The coordination of functions of these departments by various (inexpert) committees has not been very successful.

(i) A Public health engineer should be delegated with the authority as well as responsibility of Sanitation and Public health in urban areas. The health department of municipality should only monitor and advice the public health engineer from time to time.

(ii) All the operational staff available in urban areas for malaria or filaria control should be transferred to municipalities which should be made the nodal agency for vector control in urban areas.

Following steps should be taken by the local bodies before undertaking any control measure.

Identifying the Problem

a. Extensive studies on disease epidemiology and ecology and behaviour of the vector species should precede the starting of planning process.

b. Study the functioning of ongoing control programme to identify the constraints, with scope for improvement,if any. i.e.

i. Technical (changes in control strategy)

ii. Administrative (Reorganisation of power structure)

iii. Financial (generating resource by introducing service oriented tax).

c. Analyse the administrative machinery and line of power flow.

d. Define the role of different departments in prevention and control of mosquito breeding.

e. Define the role of community/beneficiary in prevention and control of mosquito.

f. Assess the expectation of the community by assessing tolerance level.

g. Assess the resource available for mosquito control and sanitation.

h. Assess the real need and priorities of the community.

With the information collected a macrolevel plan can be presented to the elected members of the local bodies and should assess the political will. At this stage a firm commitment for implementation of Public health Act, resource allocation, and structural reorganisation, if any should be obtained. If a firm commitment is not obtained from the elected member of the local body, *the programme should be dropped at this stage itself.* Any ambiguity at this stage may create problems later and the programme may fail later.

If the elected members unanimously decide to support the programme then the following steps should be taken.

i. Specify goal and objective of the programme by spelling out what can be accomplished within the resource available.

ii Fixing up responsibilities and duties of different departments of local government.

Having reached an agreement,detailed microlevel plan should be drawn by following steps.

a. Demarcate the area into operationally convenient zones.

b. Survey the area for breeding places and estimate the relative contribution from each habitat during different season and fix of control priority

c. Initiate laboratory and field studies to select appropriate control strategy and dosage of different insecticide to be applied.

d. Reallocation of staff,assign duties,and,training.

e. Procurement of supplies.

f. Work out operational procedure and logistics within a time frame.

g. Standardise evaluation and monitoring parameters and methodology to be used.

h. Implementation of the programme with a time bound plan.

II. ROLE OF ENGINEERS

Engineers have an important role in planning, designing and implementing projects which are important for the socio-economic development of the country. For example, construction of dams for developing irrigation facilities have revolutionized food production, construction works for better transport and communication facilities, housing and industrialisation, etc. However, the positive impact of such developmental activities is overshadowed by the negative impact (resulting from inadequate planning, faulty execution and lack of maintenance) on the environment and well being of mankind.

"A well meant piece of engineering, ill done, can give rise to insanitary condition which may injure the health of the very people for whose benefit it is intended" - Menon and Pillai 1958

The major casualty of developmental process has been found to be sanitation and health.High mosquito density in industrial areas, construction sites and urban cities are mainly due to man-made mosquito breeding habitats. Though the urban centres are extremely heterogenous, the common factor identified as early as 1958 is that:

"For the most part, man made foci of mosquito breeding can be attributed to the negligence and carelessness of construction engineers" - (Leprince in Mosquito Control in Panama).

Therefore this manual aims at highlighting some of the factors in engineering design and implementation contributing to mosquitogenic condition,and the ways and means of eliminating the lacunae. The defects leading to increasing mosquitogenic conditions are not necessarily intentional and is mainly due to either their ignorance of certain basic tenets of sanitation of administrative constraints.

"Engineered Mosquito Breeding Sites"

Mosquito breeding sites can be broadly classified into the following categories for convenience of the users of this manual and they are:-

1. Breeding sites related to water supply
2. Breeding sites related to water disposal,
3. Breeding site related to defective construction
4. Breeding sites due to irrigation facilities and
5. Miscellaneous breeding grounds.

1. Breeding sites related to water supply:

Various methods are employed by the community to obtain potable water. In rural India, it is usually through tubewells or wells while in an urban set-up piped water supply is also provided. Several mosquitogenic conditions arise in this process. Examples are:

1.1. Pipe line leakages: Supply of water in many urban areas is inadequate and pressure is so low that water do not reach the level of tap. As a result, the inhabitants tap the main pipeline below the ground level by digging pits resulting in extensive leakage and water stagnation. This happens mainly because extensive pipelines were laid without considering the actual available quantum of water. Hence the engineers should assess the real need of the people and availability of water before laying the pipelines. Poor quality pipes with defective joints lead to leakage of water and formation of puddles facilitating mosquito breeding. Engineers should make provision for routine maintenance and arrangements for monitoring the water lines which are liable to be tampered, at the planning stage itself. It has been observed that during planning most of the engineers do not indicate the running cost of different schemes to decision makers. As a result once the scheme is executed it never functions. For example in many multistoryed building sumps are provided to collect the water to be pumped to overhead tanks. But they do not anticipate that the pumps may breakdown. In many instances such pumps are never replaced and the people living in these apartments are forced to remove the lead and use these sumps as well which serve as ideal breeding ground for malaria mosquito *Anoheles stephensi.* This type of problem is common in government apartments built for the poorer sections of the society.

1.2. Overhead Tanks: The majority of the overhead tanks are ideal breeding ground for anopheline mosquitoes transmitting malaria in urban areas. Egg laying by mosquitoes can be stopped by providing a mosquito proof lid. If it is covered with slab they should be of the interlocking type so as to prevent any cracks.

1.3. Water Meter Boxes/ Valve chambers: Meter Boxes are generally located below ground level and water accumulates due to leakage from the pipes and joints or stagnation of rain water within them thus creating an ideal niche for mosquito breeding. Water

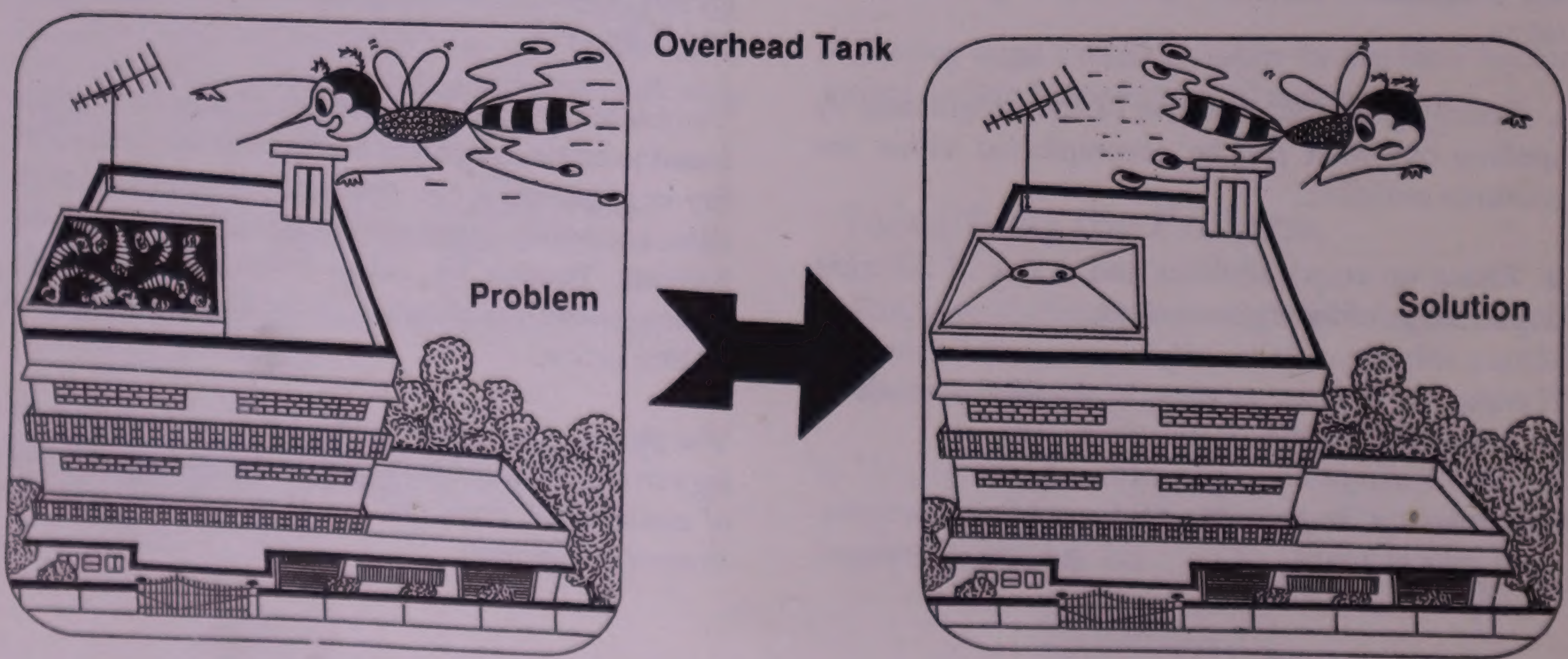
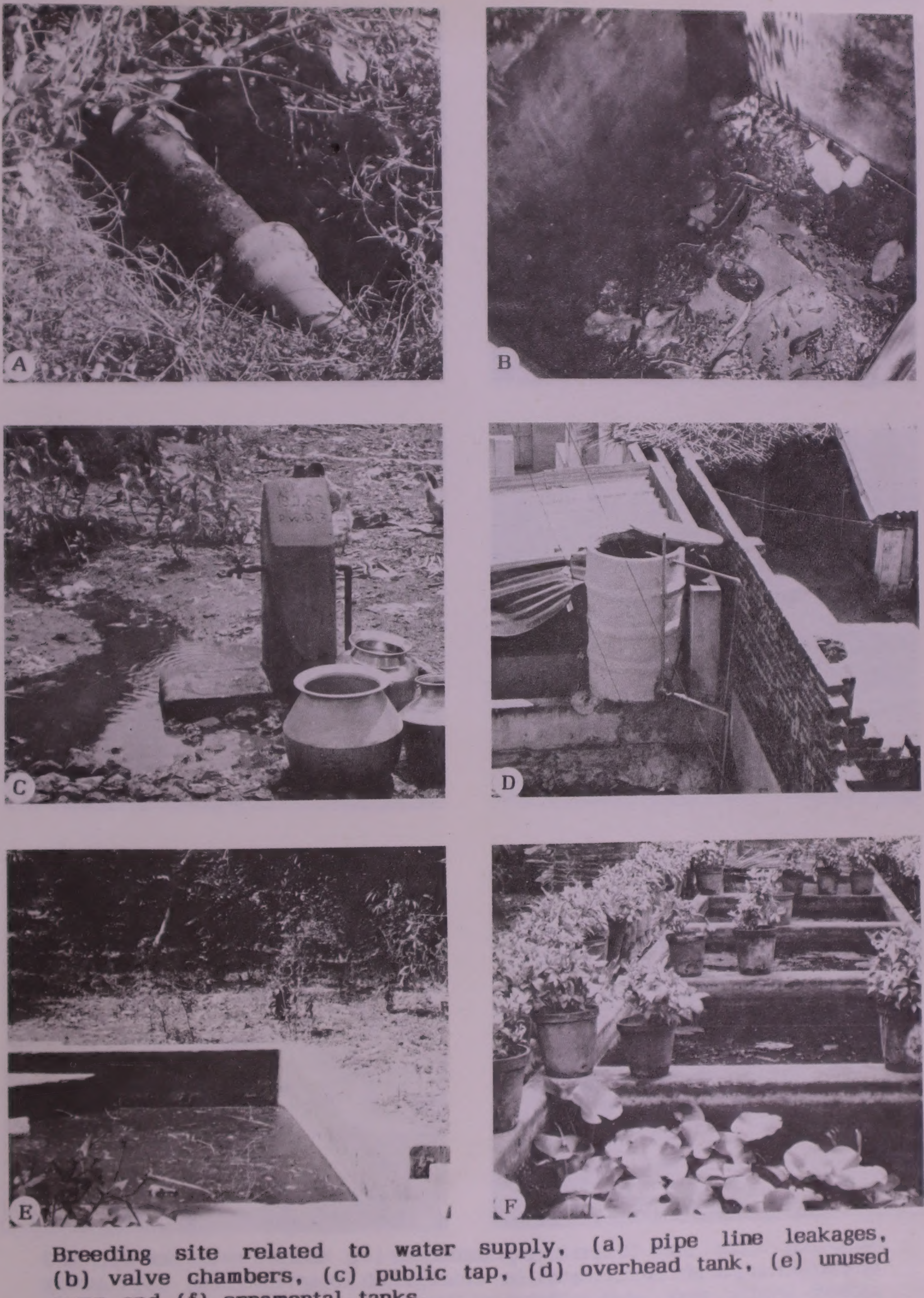
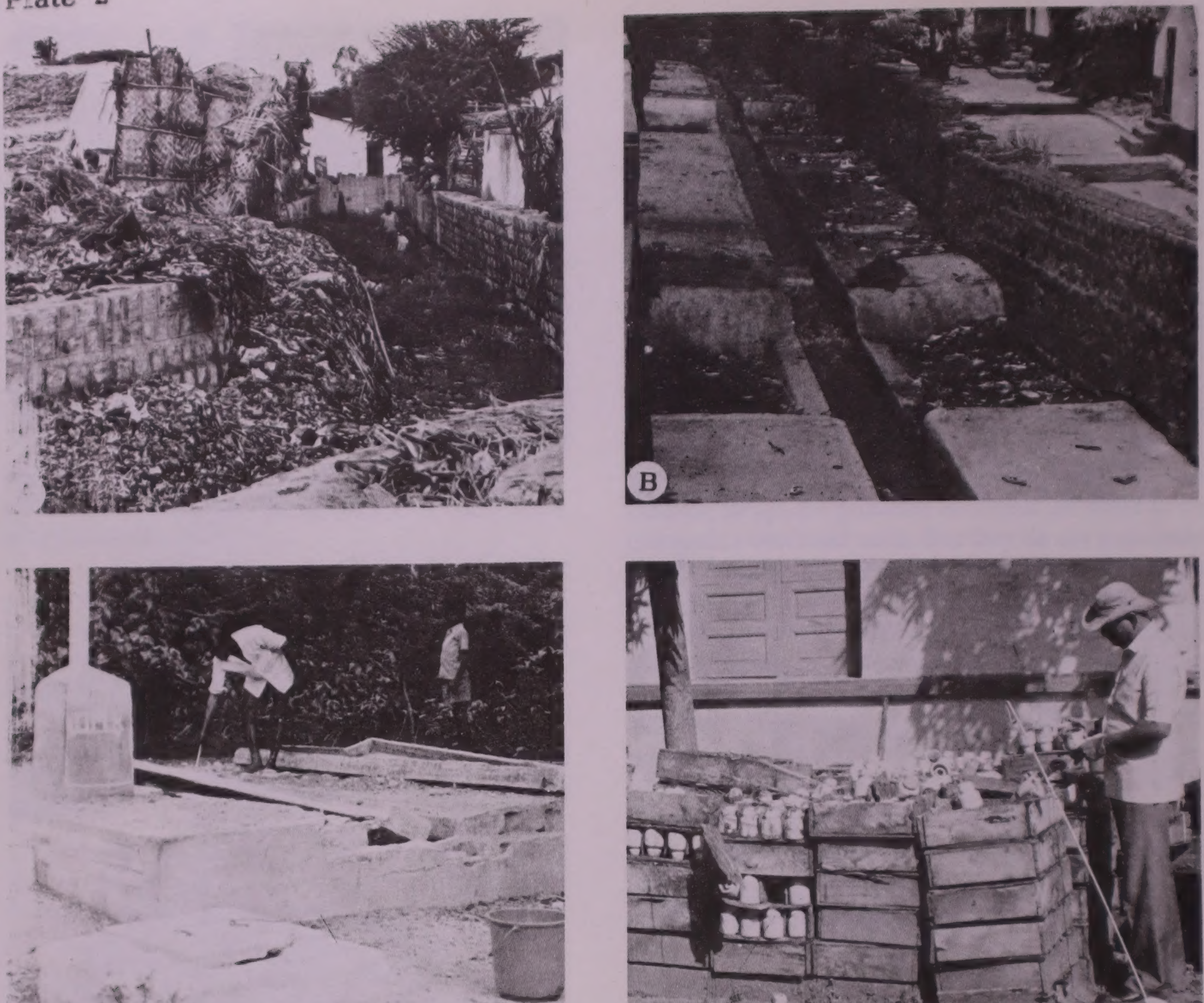


Plate 1



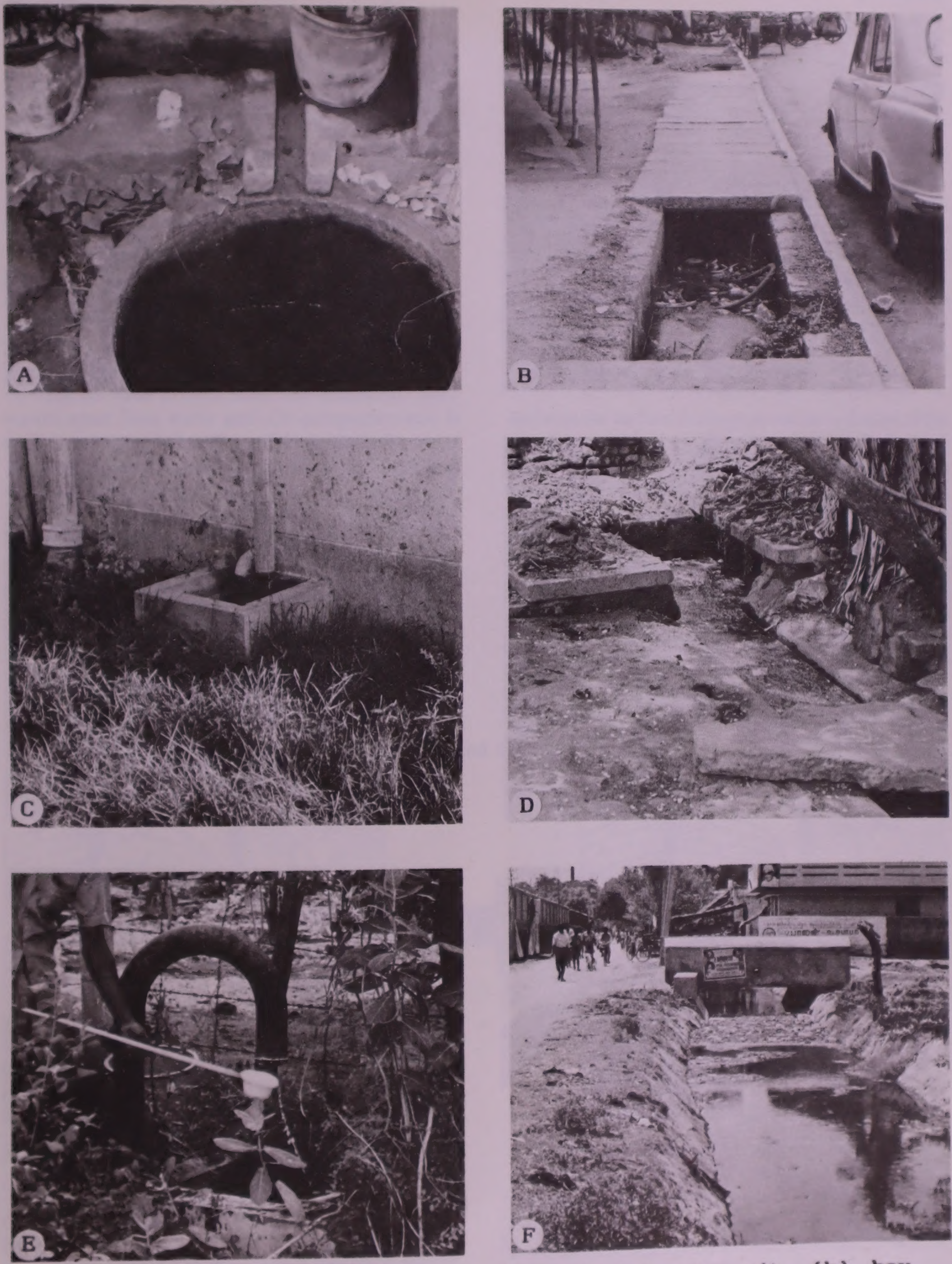
Breeding site related to water supply, (a) pipe line leakages, (b) valve chambers, (c) public tap, (d) overhead tank, (e) unused sump and (f) ornamental tanks.

Plate 2



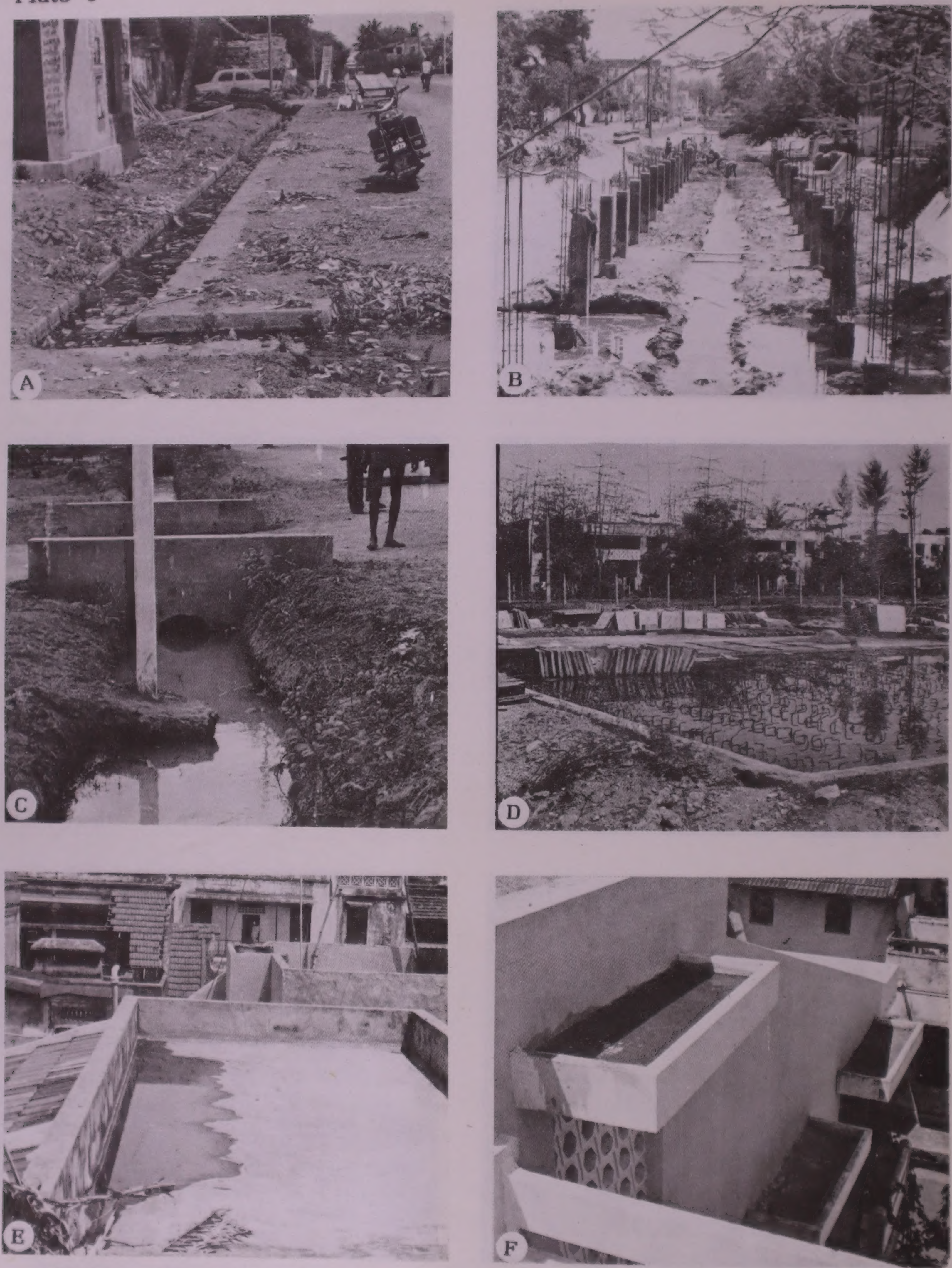
Breeding sites due to poor maintenance (a) storm water canal, (b) storm water drain with cavities at regular intervals, (c) improperly closed septic tank, (d) electrical insulators, (e) storm water canal with underground man hole in between and (f) sewage treatment plant.

Plate 3



Breeding sites related to water disposal (a) cess pit, (b) box drain, (c) gully trap, (d) blind end drain, (e) cement tank and (f) storm water canal carrying sullage and sewage.

Plate 4



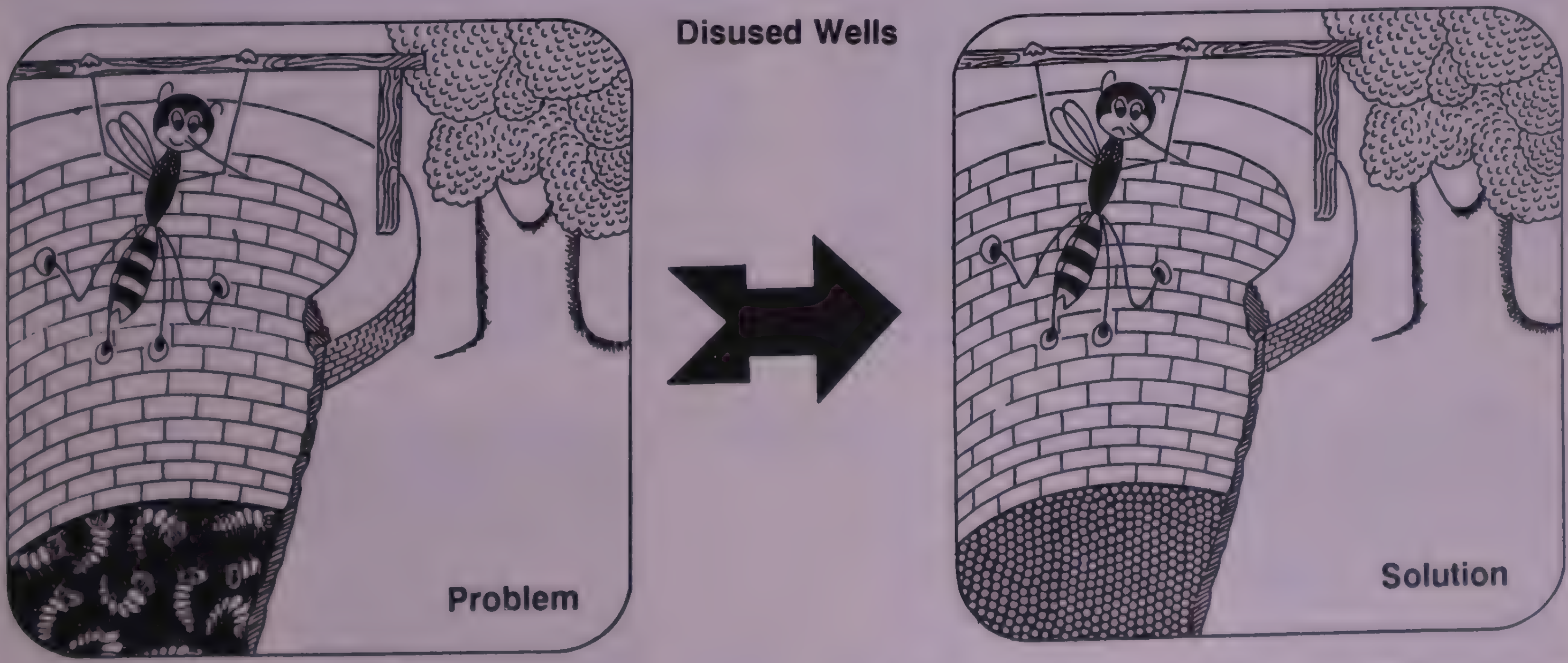
Engineered breeding sites (a) unfinished drain, (b) pillar erected on the storm water canal, (c) electric pole in the drain, (d) curing yard, (e) water stagnates on the roof and (f) sun shade.

meters should always be located above ground. If due to aesthetic reasons, metre boxes cannot be fixed above the ground level, then the base of the box should not be lined so that the soil around would be able to absorb the accumulated water . However, in areas where water table is high this method will not work. In such areas the meter box should be located above the ground level. Similar measures have to be implemented even in valve chambers which gets filled with water and can facilitate mosquito breeding.

1.4. Temporary storage tanks which remain unused: Temporary tanks are constructed to tide over the period of water scarcity. These tanks are left unused soon after rains and facilitates rapid proliferation of mosquitoes. Most of these tanks also accumulate solid wastes apart from water and *Cx. quinquefasciatus* is well known to exploit such conditions. Such situations could be avoided by closing these tanks or by stocking them with larvivorous fishes.

1.5. Disused wells: Provision of protected water supply has led to the disuse of many existing wells. The dumping of garbage and letting out the effluents into these wells converts them into ideal breeding ground for Cx. quinquefasciatus. Breeding could be prevented either by permanently closing them or by introducing expanded polystyrene beads.

Disused Wells



2. Breeding sites related to waste water disposal:

2.1. Drains : Mosquito density in a locality is related not only to the type of construction of drains but also to their maintenance. Generally there are two types of drains - one meant for sewage and sullage disposal and the other for storm water. Sewage disposal in several cities is either through underground drainage system or the surface drainage system.

A properly maintained underground drainage should not create any mosquitogenic condition. But due to lack of in built maintenance component the underground drainage frequently gets blocked and the backflow of water creates mosquitogenic conditions. The sullage water starts overflowing at various points and forms small puddles. In order to solve this problem, the engineers generally divert this water to storm water canals as a temporary measure, but this flow continues unabated permanently creating mosquito breeding grounds all along the canal.

As far as the surface drainage is concerned most of the towns have either a pukka (permanent) drain or a kutcha (temporary) one. These surface drains are the chief means of waste water disposal in most cities. Due to faulty construction pukka drains generally do not have any gradient along its course, and undersuch circumstances when the flow of water is not rapid enough, *Cx. quinquefasciatus* can breed in large numbers. Surface drains can be kept mosquito free if properly designed and maintained. Following points should be kept in mind during design construction and maintenance of the drains:

2.1.1. It should be noted that covering surface drains the drainage system dose not become an underground system. Covering surface drain for any reason will in crease mosquitogenic condition. Therefore it should never be closed so as to facilitate cleaning and larviciding if necessary. If for aesthetic reason open drains are to be closed the engineers should opt for proper underground drainage system using pipes.

2.1.2. Construction of deep drain and deep culverts should be avoided. The drains should not be deeper than their width, to facilitate cleaning. The base should slope to the centre.The design of the drains should be

U shaped and not box type. Since there is no way to prevent entry of sullage water into storm water canals, most of the storm water canals should be provided with a central cunette so as to ensure proper flow of sullage during dry weather.

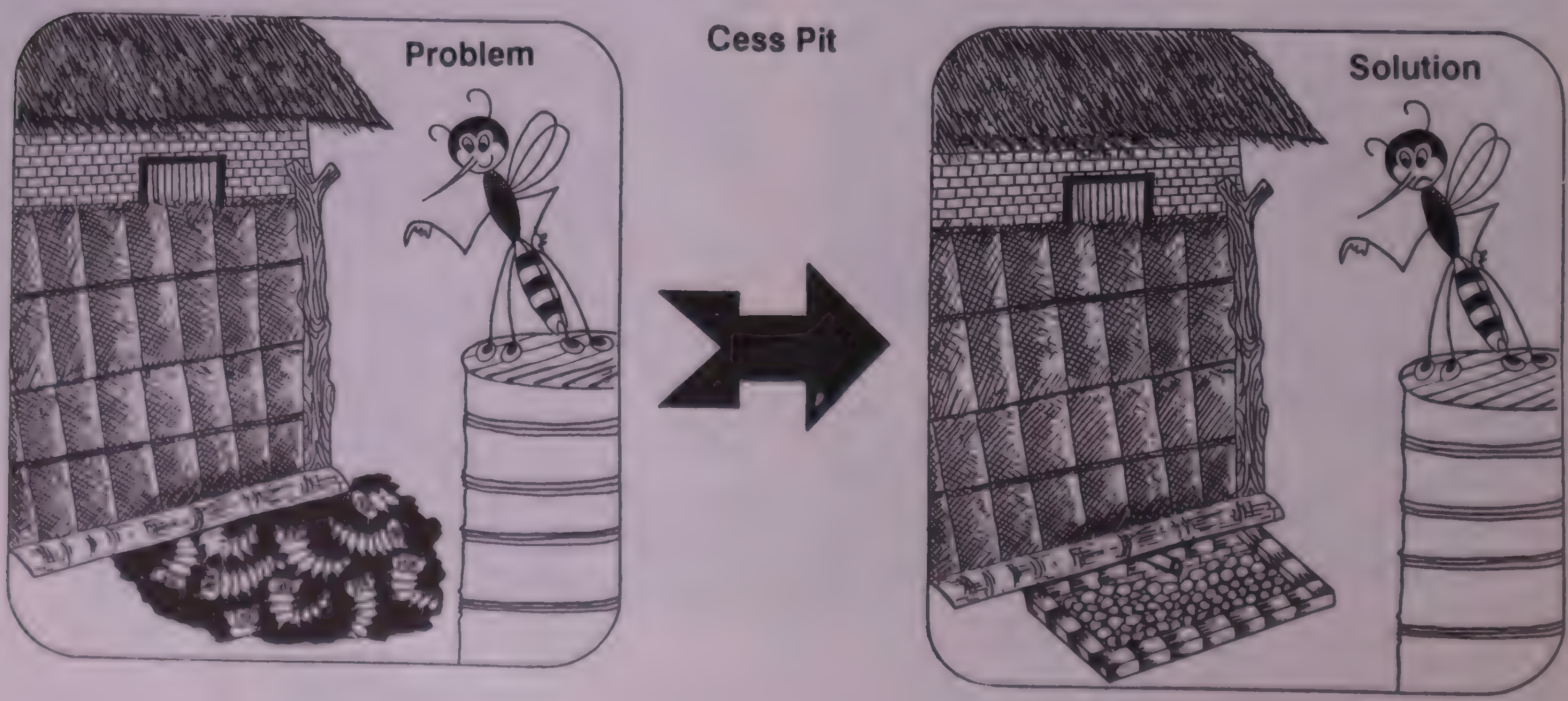
2.1.3. Occasionally piecemeal construction of drains is commonly resorted to with no proper alignment. Before undertaking any construction work engineers must ensure that the land along the proposed alignment is handed over to them up to the final disposal point. Otherwise drainage construction has to be interrupted due to pending cases in courts which usually take years with unpredictable outcome. In this situation the completed part of drainage will provide ideal site for breeding. Provision must be made for culverts across any open drain. If this is not provided, individuals are likely to place stepping stones, fill the channels with earth or obstruct them in other ways so as to be able to drive vehicles or walk across and these result in drains which are partly open and partly closed (by the bridges). As mentioned above, this is the worst possible situation.

2.1.4. In general, construction of drains should always begin at the downstream extremity and work progressively upstream. This order of construction will make it possible to see that there is a continuous downward slope along each drain. *Culex quinquefasciatus* mosquitoes can breed in water only a few centimeters deep, so that any small departure from this rule, even on a short section of drain, will provide a breeding site if the water is retained at the low point. Rigorous supervision of the contractor is required, with daily checking of the levels. Sophisticated instruments are not needed for this.

2.1.5. Gully traps, Silt Traps and Culverts: are the potential mosquito breeding sites and should therefore be avoided. If calculation for culvert capacity indicate a depth so large that the invert level would be below that of down stream, a wider, shallower culverts or a number of small culvert should be used. Otherwise, water standing in the culvert in dry weather will produce mosquitoes.

2.1.6. Finally, a town's rainwater drainage system can not be allowed to discharge into a tank or lake within 5 km of a residential area. Otherwise the wastes in the drainage water will pollute the standing water and cause mosquito breeding in that body of water, creating a health hazard. This also happens when the drainage system discharges into a natural stream of watercourse which in turn runs into such a body of water. The problem could be overcome by channelling the flow to discharge downstream of the body of water, or by treating it first. This is necessary only for the dry weather flow and additional flow during rainstorms can be discharged untreated from an overflow weir.

2.2. Cesspits: The town and country planning authorities approve the layouts without making any arrangement for waste water disposal and as a result, in many rapidly expanding towns and cities, the authorities concerned with sanitation are unable to provide disposal facilities to newer residential colonies, mainly due to administrative delay and paucity of funds. Under such conditions every household makes a cesspit in their premises, and allows the waste water to stagnate. Such pits are excel



lent breeding grounds for *Cx. quinquefasciatus* and *Armigeres subalbatus.* This could be prevented if the engineers and town planners concerned with the approval of residential areas ensure proper drainage and sewage facilities before approving the layouts. They should also prevent the development of unauthorised colonies. It is also worth mentioning that due to vested interests, engineers approve many colonies. Mosquitoes produced in these low lying areas and unauthorised slums fly to neighbouring well planned residential colonies.

2.3. **Septic Tanks:**

Septic tanks are among the most productive breeding sites for mosquitoes. Most of the localities which depend on drains for waste water disposal, use septic tanks for sewage disposal. These tanks are provided with vent pipes for the escape of obnoxious gases and an outlet for excess water to be let out. Since a majority of these outlets are left open, mosquitoes manage to enter through these pipes for egg laying and prolific breeding takes place inside these tanks. The vent pipes have to be closed with muslin cloth or mosquito net. Care should also be taken to ensure that the tanks are hermetically sealed.

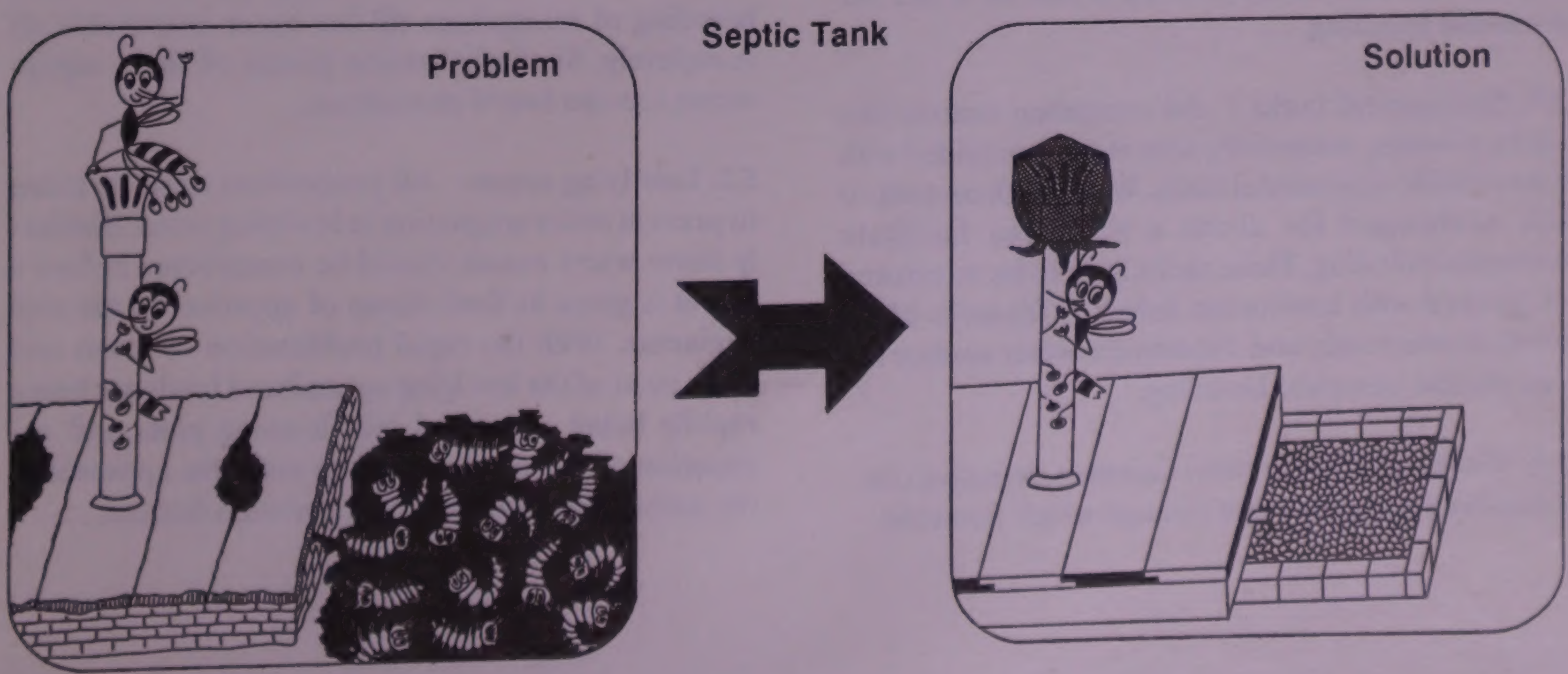
Effluents from septic tanks should not be discharged into open drains, but to a soakaway. If this is not possible, a T-piece or baffle wall should be installed near the outflow pipe to ensure that the effluent does not contain mosquito larvae which may have developed inside the tank.

A small crack in the cover of a tank, or a gap of only a few millimeters between the cover and the walls, is adequate enough for the penetration of mosquitoes and subsequent breeding. These are commonly formed when septic tanks are opened for desludging, and they may also develop cracks in course of time as a result of ground caving in. Septic tanks of public latrines, should be inspected periodically and all openings should be closed. The most practical method would be to cover the tank with sandy soil.

2.4. Public latrines: Most of the public latrines are very poorly maintained and the problem is compounded by the lack of water. The outlets of these latrines as well as its' septic tanks are not properly closed and enables breeding of mosquitoes. In designing public latrines and urinals one should consider that the sunlight is ideal disinfectant and many germs can be destroyed by the UV rays in the sunlight. Therefore the design should be such that sunlight should enter atleast for few hours in a day so that the latrines can be kept clean and dry. The engineers should desist from constructing public latrine without first ensuring adequate water supply.

3. Breeding sites in relation to construction work:

3.1. Manhole Covers: Faulty construction of covers for the drains and other sewage system can result in breeding of mosquitoes. These covers have to be suitably modified to ensure that no gap exists between them. At many places, manhole covers are found missing and efforts are neither made to prevent their pilferage nor to replace them. Generally the enthusiasm of the engineers wanes as soon as the construction is over.



3.2. Sunshades: These structures do not have a proper gradient and frequently the outlets are blocked, and serve as ideal breeding ground for mosquitoes after rains. Architects should design sunshades without any cavity within and it should have proper gradient and outlet pipe of larger size..

3.3. Roadside ditches: Small shallow pits/ditches are created by the engineers in the process of repairing roads on the sides of the road which accumulates debris and water facilitating the breeding of mosquitoes. Such stagnant puddles can be avoided if soil/mud for such work is taken from tank beds. Thus desilting of tanks and road building can be achieved with the same effort.

3.4. Incomplete and delayed construction: Paucity of funds or raw materials or in certain cases strike by the labourers or pending settlement of claims of contractor could delay the construction work undertaken for a stipulated period of time. Water accumulates at the basement of these incomplete edifices facilitating the breeding of mosquitoes.

3.5. Biogas Plants: Biogas plants accumulate water in the periphery, which in course of time gets polluted due to the contamination of cowdung. *Cx. quinquefasciatus* was found to breed in large numbers in such water bodies. Regular use of expanded polystrene beads can curtail this breeding.

3.6. Statues and Monuments: The public as well as several state Govts. spend a good part of their funds on the construction of statues and monuments. Several of these are capable of accumulating water during the rainy season at its basements (in the case of statues) or in small crevices formed due to the artistic moulding of the monument. If the water thus accumulated remains for more than a week, it can be a site for mosquito breeding.

3.7. Ornamental tanks : All recreation centres like parks, avenues, memorials, zoos etc. are provided with innumerable ornamental tanks. Water in these tanks if left unchanged for about a week can facilitate mosquito breeding. These tanks have to be monitored or stocked with larvivorous fishes. A fountain which works continuously and disturbs the water surface too can prevent mosquito breeding.

3.8. Gully traps: Yet another common defective construction is the gully traps through which domestic waste water is channelised. The cover of these traps have small depressions in which breeding of mosquitoes takes place.

4. Breeding sites due to irrigation facilities:

Construction of a dam can have a beneficial effect in reducing mosquitogenic potential in the upper reaches. The large number of isolated and scattered breeding sites in the basin, which are so difficult to identify or treat before impoundments, are submerged when the area is flooded to form the reservoir. However in the lower reaches a number of pockets is formed due to restriction of flow by dams. In such situations engineers must channelise the water by proper drainage.

The major mosquito problem in an irrigation systems is caused by the canals. In open irrigation canals, water is distributed through several lateral canals prior to its entry in the field. The greatest risk of creating mosquitogenic conditions are in the minor distribution canals and these areas are often neglected.

Any damage to the channel resulting from heavy storms and flooding, from heavy machinery, cattle crossing, etc., will alter the shape of the canal and produce water pools where mosquitoes would breed. Courses with twists and sharp bends are liable to erosion and silting, resulting in the formation of pockets with stagnant water equally suitable for mosquito breeding.

5. Miscellaneous breeding grounds:

5.1. Electrical insulators: Electrical gadgets if kept in open grounds can accumulate rain water and facilitate breeding of mosquitoes till the water evaporates off completely. Similarly broken pieces of these equipments too can breed mosquitoes.

5.2. Low lying areas : All precautions must be taken to prevent water stagnation in low lying areas. Similarly storm water canals should be constructed before a layout is given its final stamp of approval by the civil engineers. With the rapid proliferation of towns and cities most of the low lying agricultural lands are being rapidly being converted into housing plots and occupation of these areas without even the approval of the authorities concerned is a common feature.